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PYROTECHNICALLY UNLOCKABLE MECHANICAL LINKING DEVICE IMPLEMENTING A PISTON

Ins. B2

The technical scope of the present invention is that of mechanical linking devices between a first and second mechanical element, such devices being pyrotechnically unlockable.

Ins. B3

Such devices are known notably in the field of automobile safety devices.

For example, patent DE19515852 discloses a device permitting two ends of a control rod of a master automobile brake cylinder to be pyrotechnically separated. Such a separation occurs in the event of an accident so as to avoid the brake pedal impacting on the driver's ankles.

The separation device disclosed by this document implements a pyrotechnic charge arranged in a housing provided in the rod or else in a coupling sleeve between two elements forming the rod.

Separation devices are also known that implement what is commonly known as explosive bolts. Patent DE19515852 also discloses this solution, which is classically employed in separation devices used on ballistic or aeronautic vehicles.

The disadvantage of these solutions lies in that they are based on the high explosive effect of a pyrotechnic charge. Indeed, one or several primary explosives are used possibly in association with one or several secondary explosives or energetic but highly confined substances.

However, primary explosive are sensitive materials, which are thus difficult or hazardous to implement.

So as to ensure the fracture of mechanical support parts, the quantities of pyrotechnic charge necessary are also substantial (>100 mg), thereby further increasing the risks and the cost.

Known explosive bolts or other high explosive systems are thus unsuited to civil applications, notably in the area of the automobile.

Moreover, known bolts constitute locking means that are inserted transversally with respect to the elements to be joined. When the bolt is ignited, there is a risk of fragments of it remaining caught in the different elements thereby perturbing their detachment or separation. The separation effort of the two elements is thus non-reproducible and the device is not reliable enough unless an unacceptably large quantity of explosive is used.

Another device is also known by patent DE19617372 that allows two ends of a control rod for a master automobile brake cylinder to be pyrotechnically separated.

In this device the master cylinder rod is made integral in translation with the control pedal by means of a ring placed in a groove. This ring is expelled by the tensile or compressive forces exerted on the rod and it is held in the locking position by retention means that are formed by a piston pushed by a spring.

So as to ensure separation, a pyrotechnic charge is ignited that generates gases acting on the piston against the action of a spring.

The gases are also directed towards a chamber where they exert a force tending to separate the elements to be unlocked.

Such a device has a first disadvantage in that its structure is complicated and comprises numerous mobile parts and notably springs whose mechanical characteristics are likely to deteriorate over time.

This structure is thus likely to become stuck, and it also implements a large quantity of pyrotechnic composition acting notably on the mechanical elements to be unlocked so as to release the locking ring.

The gas generator is ring-shaped and is thus difficult to manufacture and integrate.

Moreover, as the effect of the gases is to act directly on the locking means, this results in a total loss of the possibility of acting on the master cylinder rod in the event of the pyrotechnic component being inadvertently ignited.

In the absence of an accident context, the triggering of the device results in the total loss of the braking capability.

Ins. B4

The aim of the invention is to propose a pyrotechnically unlockable mechanical linking device for two mechanical elements that does not suffer from such drawbacks.

The pyrotechnically unlockable mechanical linking device according to the invention is simple, compact and inexpensive in structure. It is simple to implement and permits the use of only a reduced quantity of pyrotechnic composition, such composition possibly being devoid of any primary explosive at all. In practical terms, the mass of composition alone contained in a pyrotechnic igniter for automobile safety systems can be used.

A standard pyrotechnic igniter can moreover be easily integrated inside the device according to the invention and this with no modification to its structure.

Additionally, the device according to the invention is reliable and ensures good reproducibility of the separation efforts of the mechanical elements.

The invention thus relates to a pyrotechnically unlockable mechanical linking device between a first and second mechanical element, said first and second elements likely to be subjected to tensile and/or compressive force along an axis, said device comprising at least one pyrotechnic component and at least one locking means linking the two mechanical elements along at least one axis, said locking means able to be released when the mechanical elements are subjected to tensile and/or compressive forces along said axis and held in the locking position by retention means that are released by the pressure of gases generated by igniting the pyrotechnic component, device wherein the retention means comprise a piston able to slide in an axial bore under the effect of the gas pressure generated by the pyrotechnic composition, the locking means being in contact with the piston at its

external cylindrical surface, which ensures their retention in the locking position.

According to a particular embodiment, the locking means are linked in translation with a first of the mechanical elements and comprise at least one profile co-operating with a matching profile integral with a second of the mechanical elements, the locking means also delimiting at least partially the axial bore in which the piston can slide.

The locking means can comprise at least two deformable tips integral with the first of the mechanical elements and each comprising at least one profile co-operating with a matching profile integral with the second mechanical element, such tips delimiting the internal cylindrical bore receiving the piston.

The tips will advantageously have conical external profiles.

The pyrotechnic component can be integral with the piston.

The cylindrical bore delimited by the tips can be extended by a chamber intended to receive the gas pressure generated by igniting the pyrotechnic component.

The piston may also incorporate a second cylindrical seat of a diameter less than that of the cylindrical surface or first seat retaining the tips, said second seat being positioned opposite the bore delimited by the tips when the piston is translated under the action of the gas pressure, thereby allowing the tips to bend in the direction of the piston, such bending allowing the external profile of the tips to be disengaged from its matching profile.

The second cylindrical seat may be delimited on one side by a collar guiding the piston with respect to an internal cylindrical surface of the chamber.

After the piston has translated, the collar can be housed in a groove arranged at one end of the chamber.

The cylindrical surface, or first piston seat retaining the tips can incorporate a rib co-operating with a circular

groove arranged on the cylindrical surface of the internal bore so as to ensure the axial positioning of the piston in its retention position.

The device will advantageously incorporate at least three deformable tips evenly spaced angularly.

According to another embodiment of the invention, the first of the mechanical elements carrying the deformable tips may comprise a threaded part forming the shaft of a screw, the second mechanical element will thus constitute a head for said screw.

The pyrotechnic component will thus advantageously be integral with the screw head and the axial bore receiving the piston may be arranged in the screw shaft.

The axial bore may have an internal counter-sink forming an axial abutment for the piston when it is occupying its unlocking position.

The piston may incorporate a ring-shaped sealing ring co-operating with an internal cylindrical surface of the bore.

More specifically, the screw head may comprise a body delimiting an internal chamber that will be obturated on one side by the screw shaft and on the other by a plug that will press on a peripheral protuberance of the pyrotechnic component, a spacer ring surrounding an end of the pyrotechnic component and incorporating a first abutment surface co-operating with the protuberance on the component and a second abutment surface for an end of the screw shaft so as to avoid any contact between it and the pyrotechnic component when the plug is mounted.

According to another embodiment of the invention, the locking means may comprise at least two jaws each having a profile co-operating with a matching profile integral with the second mechanical element, each jaw being able to move radially in a radial housing integral with the first element so as to be engaged in or disengaged from the matching profile, such jaws being held in the locking position by the piston.

The external profile of the jaws will advantageously be a threaded profile.

The jaws may be held in contact with the piston by at least one flexible ring.

The piston may incorporate translation stop means ensuring its immobilisation with respect to the first mechanical element, such stop means being fractured when the pyrotechnic component is ignited.

The pyrotechnic component may be integral with the first mechanical element.

The second mechanical element may be formed by a nut co-operating with the threaded profile of the jaws.

According to another embodiment, the locking means may be formed by at least two balls that will be housed in holes arranged in a tubular sleeve integral with the first of the mechanical elements and co-operating with a groove integral with the second mechanical element, the balls being held in place by the piston, which will be positioned inside the tubular sleeve and coaxial to it.

The piston may, in this case, incorporate a cylindrical seat of the same diameter as the internal diameter of the sleeve, said cylindrical seat being located opposite the holes in the sleeve thanks to positioning means.

The positioning means may comprise a shearable plate integral with the piston and pressing on a front end of the sleeve.

The device may incorporate a chamber in which the gases generated by the pyrotechnic component will develop, said chamber arranged at one end of a head integral with the second mechanical element and obturated by the shearable plate.

The groove may be made in a ring that will be made integral with the second mechanical element by crimping a band.

According to a particular embodiment of the invention, the first mechanical element may be integral with one end of a rod of a master brake cylinder for a vehicle and the

second mechanical element will be integral with a brake pedal.

Ins. B5

The invention will be better understood after reading the following description of the different embodiments, such description being made with reference to the appended drawings and in which:

- Figure 1 schematically represents the integration of an unlockable linking device according to one embodiment of the invention to link an automobile vehicle brake pedal and a master cylinder rod,

Sub, B6

- ~~Figure 2 shows a longitudinal section of a first~~ embodiment of a linking device according to the invention, said section being made along the plane referenced BB in Figure 3,

- Figure 3 is a cross section of this device, said section being made along the plane referenced AA in Figure 2,

- Figure 4 shows a longitudinal section of a second embodiment of an unlockable linking device, said section being made along the plane referenced EE in Figure 5,

- Figure 5 is a view of the preceding device as a cross section along the plane referenced CC in Figure 4,

- Figure 6 shows a longitudinal section of a third embodiment of an unlockable linking device,

- Figure 7 is a view of the preceding device as a cross section along the plane referenced DD in Figure 6, the nut and plate having been removed,

- Figure 8 shows a longitudinal section of an unlockable linking device.

Figure 1 shows a brake pedal 1 of an automobile vehicle. This pedal is hinged with respect to the vehicle floor by a shaft 2. It acts on a rod 3 of a master brake cylinder 4 by means of an unlockable mechanical linking device 5.

A hinge (not shown, such as a fork joint) is provided between the device 5 and the rod 3 so as to allow the angular clearance of the pedal 1.

Sub. B7

~~The unlockable mechanical~~ linking device ~~5 is activated~~ by control electronics 6 on the vehicle ~~to which~~ it is linked by a ~~standard~~ automobile connector 7 and a cable link 8.

~~The unlocking device 5 according to a first embodiment can be seen in detail in Figures 2 and 3.~~

It comprises a first mechanical element that is a tube 10 made integral by screwing to the end of the master cylinder rod 3.

Sub. B8

~~The tube is housed in a bore 17 of a second mechanical~~ element that is a cylindrical hub 11 ~~incorporating~~ a seat 12 of reduced diameter. ~~This~~ seat 12 is housed in a matching ~~hole~~ 13 arranged in the brake pedal 1. The hub 11 ~~is~~ made integral with the pedal 1 using a flexible ring 14 ~~that is positioned in a circular groove of the seat 12.~~

The brake pedal 1 is generally U-shaped and is made of bent sheet metal.

The two mechanical elements 10 and 11 are subjected to tensile and/or compressive forces along an axis 9.

The end of the tube 10 that is in the vicinity of the seat 12 incorporates four tips 15 separated by slits 16. The slits 16 are of a length selected so as to give the tips 15 a certain bending flexibility.

Sub B9

~~Each tip 15 incorporates a conical external profile 18~~ that co-operates ~~with a groove having~~ a matching profile 19 and arranged ~~in the bore 17 of the hub 11.~~

The four tips 15 are housed in the same conical groove 19.

The tips 15 delimit an internal cylindrical bore 20 in the tube in which a first cylindrical seat 22 of a piston 21 is positioned.

The piston 21 carries a pyrotechnic component 23 that is housed in a cavity of suitable dimensions. The pins 24 of the component are oriented in parallel to the axis 9 of the device and are directed towards a front face 25 of the device.

A housing 26 is arranged in the piston 21 and receives the connector 7 (see Figure 1) that is linked to the pins 24.

The pyrotechnic component 23 is intended to generate gases that will fill a chamber 27 prolonging the cylindrical bore 20. This chamber is delimited by an internal cylindrical surface 28 of the tube 10 and it is closed on one side by the piston 21 and on the other by an end of the rod 3.

The piston 21 incorporates a second cylindrical seat of a lesser diameter than that of the first seat 22.

This second seat 29 is delimited on one side by a collar 30 guiding the piston 21 with respect to the internal cylindrical surface 28 of the chamber 27.

The diameter of the chamber 27 is greater than that of the cylindrical bore 20 delimited by the deformable tips.

This results in an abutment surface 32 by which the collar 30 will be stopped during the translation of the piston 21.

The second seat 29 is intended to be positioned opposite the bore 20 delimited by the tips 15 when the piston 21 is translated by the action of the gas pressure and abuts against the surface 32. It is thus of a length greater or equal to the tips 15.

A circular groove 31 is made between the cylindrical surface 28 of the chamber 27 and the cylindrical bore 20 delimited by the tips.

This groove is of a diameter selected so as to prevent any interference of the tips 15 with the collar 30 when bending.

Sub. B10

~~Lastly, a first cylindrical seat 22 of the piston 21~~ incorporates a rib 33 co-operating with a ~~matching~~ circular groove arranged in ~~the cylindrical~~ surface of the internal ~~bore~~ 20 as to ensure the axial positioning of the piston 21 in its retention position.

The device operates as follows.

In the locked position shown in Figures 2 and 3, the tube 10 and the hub 11 are integral in translation with one

another thanks to the locking means formed by the tips 15 integral with the tube 10 and co-operating with the matching conical profile 19 arranged on the hub 11.

These locking means are held in the locking position thanks to the retention means formed by the piston 21 whose first cylindrical seat 22 prevents the tips 15 from bending.

Sub B11

The co-operation of the rib 33 ~~in its circular groove ensures~~ the positioning of the piston 21 ~~in its retention position and prevents any accidental displacement.~~

When the pyrotechnic component 23 has been ignited, the gas pressure that develops in the chamber 27 pushes the piston 21 towards the front face 25 of the device (in the direction indicated by arrow F in Figure 2).

In practical terms, the impulsion received by the piston when the component is ignited is enough to push the piston.

It is therefore unnecessary to provide gas tightness means for the slits 16. According to the characteristics of the pyrotechnic component a flexible plastic material or grease may nevertheless be placed in the slits so as to improve gas tightness and allow the pressure to build up in the chamber 27.

The piston 21 is displaced until the collar 30 abuts on the abutment surface 32. At this point, the second cylindrical seat 29 of the piston 21 is positioned opposite the bore 20 delimited by the tips 15.

The diameter of this second seat is less than that of the first seat 22 and is selected small enough for the radial deformation of the tips 15 to continue until their conical external profile 18 is disengaged from its matching housing 19.

The tube 10 can then translate with respect to the hub 11 following direction F, which will occur when a force of a certain strength is applied to the pedal 1 in a direction G (compressive force).

It will be noted that the tips 15 may be dimensioned such that the force causing the separation is of a given

strength (of around 150 daN). This will allow the brake to be manoeuvred in the event of the accidental ignition of the pyrotechnic component.

When the force exerted exceeds the predetermined level, the tips will be disengaged from their housing, causing the pedal and master cylinder rod to become separated and thus protecting the driver from injuries caused by the pedals.

It is easy for the person skilled in the art to dimension the tips 15 according to the force required to cause separation. It is possible to act upon:

- the depth of the grooves 16, deep grooves providing increased flexibility,
- the angle of conical profiles 18 and 19, an increase in the cone angle increasing the disengagement force,
- the width of the conical groove 19, a wide groove requiring bending and thus a greater force in order to disengage the tips,
- the width of each tip and the number of tips, narrow tips being able to bend under a lesser force.

The abutment surface 32 prevents the piston 21 from being ejected from the device thereby avoiding potential injuries.

Different variations are possible without departing from the scope of the invention.

It is thus possible to vary the number of tips 15.

It is also possible for the conical external profiles to be replaced by different profiles, for example spherical profiles.

It is also possible for the single cone profile 18 to be replaced by a profile formed of consecutive cones having a common base. Such an arrangement (as indeed that implementing spherical profiles) will allow a device to be made that is able to separate under the effect of either a tensile or compressive force.

In this case, each cone may be given a different angle and/or a different matching profile length on the hub, thereby ensuring a separation force having different

strengths in the tensile direction and the compression direction.

Figure 4 shows a second embodiment of a linking device according to the invention.

This unlockable linking device 5 allows a pyrotechnic screw 69 to be formed that provides a mechanical link between two mechanical elements not shown. The screw 69 comprises a head 67 and a threaded part 68 or screw shaft.

Conventionally, the threaded part 68 shall be made integral with a mechanical element (not shown) whereas the head 67 will press on another mechanical element (not shown).

According to this particular embodiment, the unlockable linking device 5 will thus allow a first mechanical element comprising a threaded shaft 68 and a second mechanical element formed by the head 67 to be separated.

In an analogous manner to the previous embodiment described with reference to Figures 2 and 3, the first mechanical element 68 carries four deformable tips 15 evenly spaced angularly and separated by slits 16 that may be filled with grease to improve gas tightness.

Each tip 15 incorporates a conical external profile 18 that co-operates with a matching profile 19 arranged in a body 70 of the head 67.

The four tips delimit an internal cylindrical bore 20 that receives the piston 21.

The axial bore 20 is prolonged inside the screw shaft 68 and has an internal counter-sink 71 forming an axial abutment for the piston 21 when the latter is translated and occupies its unlocking position.

An axial channel 72 prolongs the bore 20 and allows the air in the bore 20 to be evacuated when the piston 21 is displaced. The piston 21 incorporates a sealing ring 73 placed in a groove and co-operating with an internal cylindrical surface of the bore 20. This sealing ring is intended to provide gas tightness means for the pyrotechnic component 23.

The pyrotechnic component 23 is placed in an internal chamber 74 delimited by the body 70 of the screw head 67.

It is held in place by a plug 75 screwed in a female thread 76 in the body 70 and pressing by a countersink 77 on a peripheral protuberance 78 on the pyrotechnic component 23.

A spacer ring 79 surrounds one end of the pyrotechnic component 23 and incorporates a first abutment surface 80 co-operating with the protuberance 78 of the pyrotechnic component 23 and a second abutment surface 81 on which an end 82 of the screw shaft 68 presses.

Thus, when the screw is mounted, screwing the plug 75 onto the body 70 causes the axial immobilisation of the pyrotechnic component 23, which is pinched between the plug 75 and the spacer ring 79. Such an arrangement also avoids any contact between the end 82 of the screw shaft 68 and the pyrotechnic component 23. Any deterioration to the component when mounting the screw is thereby avoided.

Screwing the plug 75 also allows a mechanical bias to be exerted, by means of the ring 79, on the deformable tips 15 that are applied onto the conical profile 19.

The external profile of the body 70 of the head is, here, a hexagonal profile but any other profile allowing tightening to be carried out using a tool may be envisaged (square, cylindrical with notches for a chuck key…).

This pyrotechnic screw is mounted as follows:

First of all, the piston is positioned in the bore 20 of the screw shaft 68 in the locking position of the tips 15.

The screw shaft 68 is thereafter introduced into the body 70 of the head. The diameter of the hole passing through the head 70 is naturally greater than that of the screw shaft 68. The tips 15 are thus in abutment against the conical internal profile19 of the head body 70.

Lastly, the plug 75 carrying the pyrotechnic component 23 and the spacer ring 79 is screwed onto the body 70.

The plug (fitted with means allowing a tool having faces or notches to be engaged) is screwed until the ring

79 abuts against the end 82 of the screw shaft 68. A mechanical bias is given during this tightening so as to apply the tips 15 firmly against the conical profile 19 thereby aiding their deformation when the device is unlocked.

This device operates as follows.

When the pyrotechnic component 23 has been ignited, the gases generated push the piston 21 towards the bottom of the bore 20 until it abuts against the countersink 71.

The depth of the bore 20 is enough for the piston 21, when in this unlocked position, no longer to be opposite the deformable tips 15.

As the axial forces tend to push away the shaft 68 and the head 67, that is to say the usual forces due to tightening a screw, this will result in the deformation of the tips 15, which will be pushed away by the conical profile 19.

The screw shaft 68 will then separate from the screw head 67. The separation is made easier by the initial mechanical bias given by tightening the plug 75 when the device is mounted.

It is naturally possible to vary the number of tips 15 in such an embodiment.

Such an unlockable linking device may be used in any application as simply as a normal screw. It ensures separation further to a tensile force exerted between the shaft and the screw head.

Such a screw or device may be used, for example, to link an air-deliverable load to an aircraft.

Figure 6 shows a third embodiment of a linking device according to the invention.

This unlockable linking device also constitutes a pyrotechnic screw 5 that allows a first mechanical element 10, which here is a tube attached at a rear cylindrical part of the screw 5, for example by threading, to be linked to a second mechanical element comprising a plate 34 held by a nut 36.

Within the scope of a particular application, the tube 10 may be integral with the carrier of an air-deliverable charge, for example an aircraft, and the plate integral with an airborne load such as a fuel tank or bomb. In this case, this device would allow the separation of the load and the aircraft to be commanded at a given time.

The pyrotechnic screw 5 presses on the plate 34 at a shoulder 35 and the second mechanical element comprises the nut 36 co-operating with the screw 5. The nut 36 is a conventional hexagonal nut that is applied to the plate 34 by screwing.

The screw 5 comprises a body 37 that has an axial housing intended to receive a pyrotechnic component 23.

The body 37 incorporates a rear cylindrical part 37a onto which the tube 10 and a hexagonally-profiled front part 37b (see Figure 7) is screwed so as to make screwing easier using conventional tooling (wrenches).

The axial housing of the body incorporates a conical abutment surface 38 that co-operates with a protuberance 39 on the component 23. The axial housing incorporates a female thread 40 that receives a threaded support 41 incorporating two cylindrical parts 41a and 41b separated by the shoulder 35.

The support 41 is sectioned by an axial bore 42 prolonged on the body 37 side by a countersink 43 capping the pyrotechnic component 23.

Thus, the pyrotechnic component 23 is pinched and immobilised between the support 41 and the body 37.

The support 41 also has a transversal groove 44 that passes right through the cylindrical part 41a, perpendicularly to the axis of the bore 42.

This groove thus forms two housings in the support 41 that each receive, in a radially sliding manner, a jaw 45 having a shape matching that of its housing.

The groove may be of a rectangular shape or else, more advantageously, a milled groove ended by two semi-cylindrical portions.

Each jaw 45 has a threaded external profile 45a that is intended to co-operate with the nut 36 and a cylindrical-portioned internal profile 45b intended to co-operate with a piston 21.

The piston 21 is of the same diameter as the bore 42 and is thus guided by this bore on either side of the grooves 44.

The jaws 45 are held in contact with the piston 21 by a flexible ring 46 housed in matching grooves made in the jaws 45.

The ring 46 is, for example, a split ring made of metal or a plastic material. It retains the jaws before a nut is screwed in placed.

The external diameter of the cylindrical part 41a of the support 41 is slightly less that the diameter at the crest of the female thread of the nut 36.

It is thus possible for the nut to slide on the cylindrical part 41a without sticking.

The jaws are dimensioned such that when the are held against the piston 21 by the ring 46, they both protrude from their grooves 44 by a length such that their threaded profile 45a fully corresponds to the female threading of the nut 36 (see Figure 7).

Lastly, the piston 21 carries translation stopping means 47 ensuring its axial immobilisation with respect to the support 41, and thus with respect to the first mechanical element 10.

These stopping means are formed, for example, by a ring of plastic material, such as a polyamide or else rubber placed in a circular groove of the piston 21.

The selection of rubber for this also allows the gas tightness of the assembly to be reinforced with respect to the gases generated by the pyrotechnic component. The ring will be fractured when the pyrotechnic component is ignited so as to allow the piston to translate.

This linking device operates as follows.

When the pyrotechnic component 23 has been ignited, the gases generated push the piston 21 in its bore and eject it from the screw 5.

The jaws 45 are no longer held radially by the piston. Thus, an axial force between the screw 5 and the nut 36 (thanks to the co-operation of the threaded profiles of the jaws and nut) will result in the jaws 45 being pushed towards the inside of the axial bore 42.

The screw 5 thereafter separates from the nut 36.

It is naturally possible to vary the number of jaws 45 in such an embodiment.

An external profile 37b may also be given to the body 37 that is different in shape: square, cylindrical with notches to allow tightening.

Such an unlockable linking device may be used in any application as simply as a normal screw.

It also mechanical element subjected to tensile forces to be separated. Such a screw or device may, for example, be used to link an air-deliverable load to an aircraft.

Figure 8 shows an unlockable linking device according to a fourth embodiment of the invention.

This device links a first mechanical element, which here is a rod 10 (to the left of this Figure), and a second mechanical element 49 (to the right of the Figure), which here is a hollow rod.

According to this embodiment, the locking means are formed by balls 48 housed in radial holes 50 arranged in a tubular end 51 of the first mechanical element 10.

The linking device comprises a head 52, fastened to an end of the hollow rod of the second element 49, for example, by radial screws (only one axis 53 of which is shown).

The head 52 receives a pyrotechnic component 23 fastened in a countersink 54 arranged in the head 52 by ring-shaped crimping 55. This component is connected by wires, not shown, to electronic activation control means. The wires pass through the hollow rod 49, for example through a side opening 66.

The holes 50 receiving the balls 48 are evenly spaced angularly on the tubular end 51 of the first element 10.

At least two balls will be provided (here four balls have been used).

The balls co-operate here with a groove 56 delimited by the conical profiles 57a, 57b and made in a ring 58.

The ring 58 is made integral with the head 52, and thus with the second mechanical element 49, by crimping a cylindrical metal band 59. Crimping is carried out, firstly at a peripheral shoulder 60 of the head 52 and secondly, on an end 61 of the ring 58.

According to this particular embodiment, the balls 48 are retained by a piston 21 placed inside the tubular end 51 and coaxially to it.

The piston 21 incorporates a cylindrical seat 62 of the same diameter as the internal diameter of the tubular end 51 forming a sleeve. The cylindrical seat 62 is held opposite the holes 50 thanks to positioning means 63.

The positioning means 63 comprise a shearable plate integral with the piston, for example, by bonding and which presses on a front end of the first element 10.

The shearable plate 63 is held pinched between the ring 58 and the head 52.

The plate will, for example, be made of a light alloy or else of a plastic material whereas the piston may be made of steel. The ring 58 will, for example, be made of steel.

This device is assembles as follows:

- first of all the ring 58 is positioned alone opposite the holes 50,
- the balls 48 are placed in the holes, they will be temporarily held in place, for example, by grease,
- the piston 21, which retains the balls, is set into place,
- the equipped head 52 of the component 23 is set into place,
- the band 59 is set into place and is made integral by crimping the ring 59 and the head 52.

After assembly, the device incorporates a chamber 64 in which the gases generated by the pyrotechnic component 23 will develop.

The chamber is arranged in the head 52 and is obturated by the shearable plate 63.

This device operates as follows.

When the pyrotechnic component 23 has been ignited, the gases cause the plate 63 to be sheared and push the piston 21 in the internal cavity 65. The relative lengths of the piston and cavity will be selected such that, when the piston abuts at the cavity 65 bottom, the cylindrical surface 62 is no longer in front of the holes 50 which receive the balls 48.

These latter are no longer held radially in contact with the groove 56. A tensile and/or compressive force along directions F1 or F2 will therefore cause the balls to be ejected towards the inside of the cavity 65 because of the co-operation of the conical profiles 57a, 57b of the groove with the balls. The two elements 10 and 49 are thus separated.

In this as in the previous embodiments, the advantages of the invention lies in that the pyrotechnic component acts on an element (the piston 21 carried by the plate 63), which does not participate in the transmission of forces between the first mechanical element 10 and the second mechanical element 49.

It is thus possible to have an extremely rigid mechanical link between these two element whilst ensuring the easy, reliable and fast separation of these two elements using a component implementing a reduced mass of pyrotechnic composition. Indeed, the pyrotechnic component does not have to fracture a mechanical element ensuring the transmission of the tensile and/or compressive forces, but has only to fracture a plate 63 whose thickness may be relatively reduced. After displacement of the means (the piston) ensuring the retention of the locking means (the balls), a reduced tensile or compressive force on one of

other of the mechanical elements 10 or 49 will eject the locking means 48 and separate the two elements.

The plate 63 may also incorporate an incipient fracture, for example a ring-shaped groove.

Such a device is unlocked both when subjected to a tensile force (direction F1) and when subjected to a compressive force (direction F2). It may thus be used as that shown in Figures 2 and 3 to connect a brake rod to a brake pedal (compressive force). It may also, similarly to the pyrotechnic screws shown in Figures 4 to 7, be used to connect a load to a carrier (tensile force).

By way of a variant, it is once again possible for a profile matching that of the balls to be selected for the groove 56 that has a different shape, for example a circular section profile of the same diameter as that of the balls.